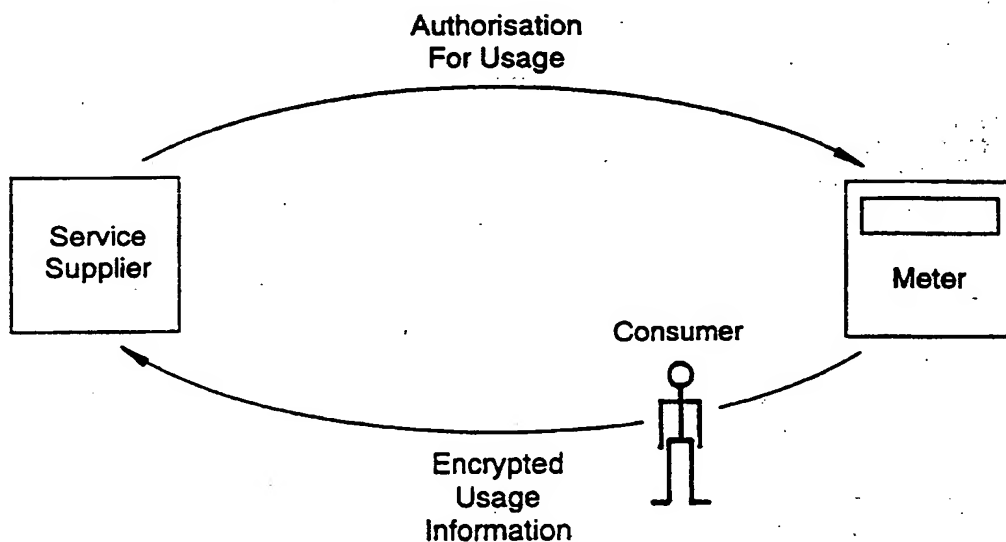




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(21) International Application Number: PCT/NZ98/00073 (22) International Filing Date: 3 June 1998 (03.06.98) (30) Priority Data: 314995 3 June 1997 (03.06.97) NZ (71) Applicant (for all designated States except US): TOTAL METERING LIMITED [NZ/NZ]; Wilbank House, Level 3, 57 Willis Street, Wellington (NZ). (72) Inventors; and (75) Inventors/Applicants (for US only): RYAN, Regan, Brendan [NZ/NZ]; 10B Oriental Terrace, Wellington (NZ). GOWANS, Dean, Syme [NZ/NZ]; 78 Townsend Road, Miramar, Wellington (NZ). (74) Agents: CALHOUN, Douglas, C. et al.; A. J. Park & Son, Huddart Parker Building, 6th floor, Post Office Square, P.O. Box 949, Wellington 6015 (NZ).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

(54) Title: IMPROVEMENTS RELATING TO METERING SYSTEMS



(57) Abstract

Metering arrangements between a supplier (1) of services such as electricity, water or gas and a consumer (2), in which the consumer conveys encrypted usage information to the supplier. Equipment (3) generally including a visual display (4) is installed at the consumer premises and may be operated by the consumer on a voluntary basis. Incentives such as rebates are provided for the consumer to provide the information to the supplier. The arrangements may be part of a prepayment system or a more traditional system involving statistical estimation and billing of the supply.

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IMPROVEMENTS RELATING TO METERING SYSTEMS

FIELD OF THE INVENTION

- 5 This invention relates to metering of utility and like services, and in particular but not solely to electricity metering systems. The invention also relates generally but not only to prepayment systems in which quantities of a commodity such as electricity, water or gas are effectively purchased from a supplier before consumption.

10 BACKGROUND TO THE INVENTION

- Various prepayment systems have been described for use with electricity metering equipment. Examples can be found in NZ 236202, GB 2,208,955 and EP 420466. A consumer operates a system of this kind by purchasing or replenishing a token with credit
15 issued by a supplier of electricity, or of some other commodity as required. The token is typically a swipe card or numerical code which is presented by the consumer to their metering equipment. The equipment interprets the token and enables use of electricity at the consumer premises according to the amount of credit.
- 20 Prepayment systems do not generally remove the need for both utility suppliers and consumers to monitor individual usage of the particular commodity. The demand and cost of electricity, for example, varies on a half hourly basis in most countries, and several suppliers may share a common distribution network. Prepaid electricity provided by a particular supplier to a particular consumer is not identified directly but is usually
25 estimated by statistical analysis. The analysis is assisted by usage information which can be obtained from the respective consumers in a variety of ways. The consumers may also benefit by providing usage information, in that rebates may be given for better than average off-peak consumption, for example.
- 30 Electricity usage is traditionally extracted from metering equipment by an employee of the supply organisation who visits each consumer site on a monthly or bimonthly basis. A reading device is manually connected to an output port of each meter so that quantity and time of use data can be downloaded. In some relatively complex metering systems, usage information may be transmitted from metering equipment directly to the supplier
35 over a telephone line connection, or over the supply network itself. Other systems for conveying usage information back to the supplier also exist but none are particularly convenient for the consumer.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide improved methods and apparatus for assistance in conveying usage information from a consumer to an electricity
5 supplier. Such methods are implemented relatively simply and cheaply by giving the consumer incentives to play an active role.

Accordingly in one aspect the invention may broadly be said to consist in meter apparatus for location at consumer premises, including: memory means which receives and stores
10 information relating to usage of a service by the consumer, processing means which retrieves and encrypts the usage information, and output means by which the encrypted information is presented to the consumer.

Preferably the apparatus also includes input means by which the consumer prompts the processing means to encrypt and present the usage information. The input means may
15 comprise a push button, for example. Preferably the output means presents the encrypted information visually in a predetermined format. The output means may comprise an LCD device, for example.

Preferably the apparatus also includes metering means which physically monitors and/or controls use of the service by the consumer and provides usage information for the memory means. Preferably the apparatus includes signal reception means by which a
20 service provider organisation is able to control operation of the apparatus. The signal reception means may comprise a paging signal receiver, for example.

In another aspect the invention may be said to consist in a method of processing and providing information at consumer meter apparatus in a service metering system, including: receiving a prompt from the consumer that information is required, retrieving
25 usage information from storage in the meter apparatus, combining other meter related information with the usage information, encrypting the combined information, and
30 providing the encrypted information for the consumer.

Preferably the consumer prompts the system for information manually, such as by way of a push button. Preferably the encrypted information is provided for the consumer in
35 a visible or audible form. Preferably the usage information includes profile data. Preferably the other meter related information includes one or more of identification, meter status, tamper status, time, and error correction data.

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In a further aspect the invention may also be said to consist in a method of conveying usage information from a consumer site to a service supplier site, including: recording the usage information in meter apparatus at the consumer site, encrypting the usage information when prompted by the consumer, providing the encrypted information to the consumer in a readable form, receiving the encrypted information from the consumer at the service supplier site, decrypting and analysing the received information, and offering the consumer a rebate on future usage as result of the analysis.

Preferably the consumer prompts encryption and provision of the usage information by activation of a manual control at the consumer site. The information may be provided on an LCD readout, typically in a fixed length format. Preferably the information contains identification and profile data. Preferably the encrypted information is received from the consumer over a telecommunications system, such as by telephone, facsimile or email.

In one embodiment the consumer may be required to prepay the supplier before the service can be consumed. Prepayment involves provision of usage information according to the invention. The supplier may then provide authorisation for use of the service by way of an access code which is presented to the meter apparatus by the consumer, or by way of a remote control signal. Remote control may be provided over the service supply network itself, or as a paging signal, for example.

In another embodiment the consumer uses the service in a traditional manner without prepayment, and actively provides usage information for the supplier on an intermittent basis according to the invention. The supplier may then issue charges to the consumer based on the usual statistical analyses, incorporating rebates for any economical usage revealed by the information as it comes to hand.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will be described with reference to the drawings, of which:

Figures 1a, 1b illustrate in general terms how a service supplier and consumer may form a metering arrangements for use of the service,

Figure 2 is a schematic diagram of electricity meter apparatus which may be installed at the consumer premises according to the invention,

Figure 3 shows a keypad and display of the apparatus which are used in the preferred embodiment for input and output of information,

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Figure 4 is a flowchart indicating how the apparatus generates a meter reading with encrypted usage information when prompted by the consumer,

Figure 5 is a flowchart indicating how the encrypted information may be conveyed to a computer system operated by the service supplier, and

5 Figures 6a, 6b, 6c show data structures for a prepayment token and for alternative forms of the information output by the meter, by way of example.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

10 Referring to these drawings it will be appreciated that the invention may be implemented in various ways without departing from the general concept of a consumer actively conveying encrypted usage information (ie. the meter reading) to a service supplier. The information is encrypted to reduce the possibility of deception by the consumer. It will also be appreciated that supply of various metered services such as electricity, water and
15 gas are all within the scope of the invention.

Figures 1a and 1b indicate generally two kinds of relationship for conveying usage information between a service supplier 1 and a consumer 2. In each case a meter 3 is installed at the consumer premises and provides encrypted usage information on a display
20 4 for the consumer to convey to the service supplier. Figure 1a shows a partially consumer-based process in which the meter 3 is activated remotely by the service supplier so that the consumer is able to use the service. An authorisation signal may be sent to the meter over an electricity or telecommunications network for example, or the meter may be activated by a representative of the service supplier. Figure 1b shows a fully
25 consumer-based process in which the meter is activated by an authorisation code issued by the service supplier and carried by the consumer. The code might be issued as part of a credit allowance in a prepayment system, for example.

Figure 2 is a schematic diagram showing possible components of electricity metering
30 equipment according to the invention. These components are contained by a sealed housing located at consumer premises. The equipment is monitored by a microprocessor 10 which receives manual input from a keypad 11 and generates output for the consumer on a display 4 such as an LCD. Other forms of input and output might be employed instead of or in addition to the keypad and display, such as data transfer to and from a
35 personal computer. A full keypad may be unnecessary in a relationship such as indicated in Figure 1a where the meter is activated directly by the service supplier.

The microprocessor 10 receives electricity usage data from a metering unit 13 which is typically provided as part of the equipment but may be installed as a separate component. The microprocessor is able to turn off usage by the consumer through switch 14 under various circumstances, such as when credit for a prepaid quantity of electricity is exhausted or when the meter is deactivated directly by the service supplier. Attempts by the consumer or others to interfere with the equipment are noted by the microprocessor through tamper indicating system 16 and the supply of electricity could be disabled should tampering occur. A real time clock 17 provides timing signals for operation of the microprocessor, and enables time-based recordal of information relating to consumer usage of the service.

A broadcast receiver 18 may be included in equipment to provide an arrangement such as indicated in Figure 1a. Paging signals may then be transmitted by the service supplier for various purposes such as authorisation to use the service, typically with a credit limit, load control messages, clock, tariff or profile change messages, and changes to the encryption process such as fresh keys. Alternative means of direct communication by the service supplier may also be provided such as mains borne signalling, television teletext signalling or digital subscriber line processes.

A memory 15 is shown in a generalised form to store variable and fixed data as required by the microprocessor for operation of the metering equipment. Non-volatile devices such as EEPROM or flash memory would typically be used. Electricity usage data obtained from the metering unit 13 is stored in memory portion 4 according to a predetermined scheme. In a coarse recordal scheme, data representing kWh consumption may be stored simply for day/night or weekday/weekend periods. In a relatively fine recordal scheme, data might be stored at half hourly intervals over a one or two month period. Memory portion 5 stores a range of usage profiles which represent standard patterns of consumer usage over daily, weekly or other suitable periods, against which the actual usage at particular premises may be compared. Up to perhaps one hundred may be stored in practice.

Memory portion 6 stores encryption and decryption algorithms which are used to produce coded usage tokens for the consumer as explained below, and to decode credit tokens or other messages which may be issued by the service supplier. A secret key will also be stored for most encryption and decryption processes. Algorithms such as DES will be well known to the skilled reader and need not be described. A dedicated encryption/decryption processor may be provided separately. Portion 7 of the memory

stores calendar information which enables the microprocessor to determine date and time from the real time clock 17 when storing usage data, generating output, receiving input, or other events. Portion 8 is reserved for various system settings such as the recordal schemes mentioned above, and the structure of tokens containing usage information.

5 Portion 9 stores a series of time stamps as produced by the microprocessor when generating tokens containing usage information. Other portions of the memory store information such as equipment number, tamper indications and other data but need not be specifically shown.

10 Figure 3 shows a simple interface 20 which may be mounted on the housing of the metering equipment for the consumer. In this example, the interface includes display 4 which is typically an LCD arrangement having space for presentation of perhaps four or more characters, and a keypad 11 having numeric and function keys, and perhaps alpha keys. An interface of this kind is cheap and robust, although both simpler and more
15 sophisticated systems are readily envisaged. For example, a single button D is all that may be required in a system which does not involve prepayment. The display may be blank or may perhaps contain an instantaneous usage reading when the equipment is inspected. A consumer prompts the equipment for output by pushing key D. All or part of a coded token containing a meter reading is then presented on the display and may be
20 copied down manually. If only part of the token is presented the consumer continues to push key D and record the contents of the display until the full token has been output. To input a coded token representing a prepaid quantity of electricity the consumer pushes key E and then enters part or all of the token. If the equipment can only receive sequential parts of the token then each part is keyed separately followed by key E until the entire
25 token has been input. Other keys to enable functions such as character clearance in the display, and electricity on/off will also usually be provided.

A coded output token contains various items of information for the electricity supplier including a meter reading, as will be explained below. It is important that the token be
30 available in a suitable alpha or numeric form, preferably a visible form, which does not require any particular transfer device such as a swipe card. A note on a scrap of paper or a preprinted sheet, for example, will be sufficient record of a token to enable the information to be passed on to the supplier. A token which can be downloaded to a personal computer and recalled by the consumer from a file is another example. The
35 token is encrypted by the equipment to prevent the consumer from interfering with the information content which must be passed to the supplier for analysis. It will preferably have a fixed length numeric format as explained below to ensure simple and reliable

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recordal by the consumer under domestic circumstances. The consumer may then pass the token on to the supplier in various ways, by telephoning a voice response service operated by the supplier, for example, and using touch tone keys to convey the digits, or by telephoning and presenting the token verbally to a human representative of the supplier. Other possible methods of conveying the token include a physical transcription which is mailed or faxed to the supplier, an electronic transcription which is sent by email, input at a retail funds transfer terminal, or generally any communication system which the supplier may choose to facilitate for the consumer.

Figure 4 is a flowchart which broadly outlines a routine which may be used by the microprocessor 10 to present a coded token to the consumer in the display 4. The equipment normally presents an updated display in step 30, such as an instantaneous meter reading in kWh, credit remaining in dollars, or rate of electricity consumption in monetary terms, for example. In step 31, a prompt by the consumer at the interface 20 causes the microprocessor to retrieve data from the memory 15 and construct a token in steps 32 to 34. The service supplier may also prompt the equipment to retrieve information and produce the token, by way of the broadcast receiver 18 for example. A predetermined format required by the supplier is forms the basis for the token, including date/time information, total usage and one or more patterns of usage. Other information such as meter status and tamper indications would also usually be included in step 35. If the consumer has not requested an output from the equipment for some time then older usage information may have been overwritten in the memory position 12 and the consumer will have been charged at standard prepayment rates. The token is encrypted in step 36, perhaps using a DES algorithm, and displayed for the consumer, perhaps in a series of parts as indicated by the steps of loop 37. Parts of a twenty digit code for example, could be displayed as five parts of four digits each. If the consumer abandons the event before output of the full token then a timeout process returns the display to the normal state. A range of encryption algorithms may be used and will be well known to the skilled reader. An algorithm which uses a meter or consumer identification number is presently preferred, and a number key of this kind can be passed by the consumer to the supplier in addition to the token if required.

Figure 5 is a flowchart broadly outlining an interactive voice response process which may be implemented on a computer system operated by the supplier. After consumers have recorded an encrypted token from their metering equipment they may telephone the computer system to convey the output, perhaps while ringing for some other purpose, such as to obtain further prepayment credits. The computer system receives incoming calls and

prompts each caller for information of the required kind in an appropriate format. Identification details and the encrypted token are provided by each consumer using touch tone keys on their telephone in a well known manner, and validated by the computer system. In this example, a meter number is requested in step 40 and validated in step 41.

5 If the information is not valid for some reason or another the consumer is asked to repeat their input. The process indicated by this flowchart is generally self explanatory. The process by which the supplier decrypts the usage information in step 42, and then analyses the information received from each consumer also need not be discussed in depth. In general, the supplier will offer rebates for usage patterns achieved by the consumer which
10 depart from the standard tariff at which charges would normally be made, or at which credit may previously have been issued. This encourages the consumer to convey the usage information to the supplier on a reasonably frequent basis.

Figures 6a, 6b and 6c are example tokens which may be used in a metering arrangement
15 between a service supplier and a consumer according to the invention. Figure 6a is a token such as might be encrypted and issued by a supplier in the arrangement of Figure 1a. Figures 6b and 6c are alternative tokens such as might be encrypted and displayed by the consumer metering equipment in either Figure 1a or Figure 1b. Each token is preferably 64 bits in length to conform with STS protocols and the DES encryption
20 algorithm. Each contains a number of fields preceded by a two bit header 50 which indicates the general nature of the token and preferably remains unencrypted. The fields common to each token include a class field 51 which further indicates the nature of the particular token, a date/time stamp 52 and a CRC checksum 53. The class field may alternatively include additional meter related information such as a meter reference
25 number or tamper indication.

In Figure 6a which might represent a prepayment token, a 4 bit random pattern 60 is included to increase complexity and variability in the encrypted result. The amount field
54 contains a representation of the usage that has been credited to the consumer, typically
30 measured in kWh. This would be calculated simply by dividing a monetary amount paid to the supplier, by the tariff applicable to the particular consumer. It should be noted that prepayment or other authorisation systems which may be implemented by a supplier, such those indicated in Figures 1a and 1b, are not necessarily part of the invention.

35 In Figure 6b which represents a preferred meter reading token, a sequence of 28 bits are divided into a total kWh field 55, a weekday profile field 56 and weekend profile field 57, containing 16, 6, 6 bits respectively. The total in field 55 is an absolute quantity which

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for an average domestic consumer using around 10 kWh/annum would rollover in perhaps 6 to 7 years. A comparison by the supplier between the latest and previous totals gives consumption for the period between their respective time stamps. An absolute rather than relative total is preferred to reduce any likelihood that the encrypted information may be compromised. Fields 56 and 57 index respective profiles from portion 5 of memory 15 to indicate average usage patterns during weekday and weekend periods.

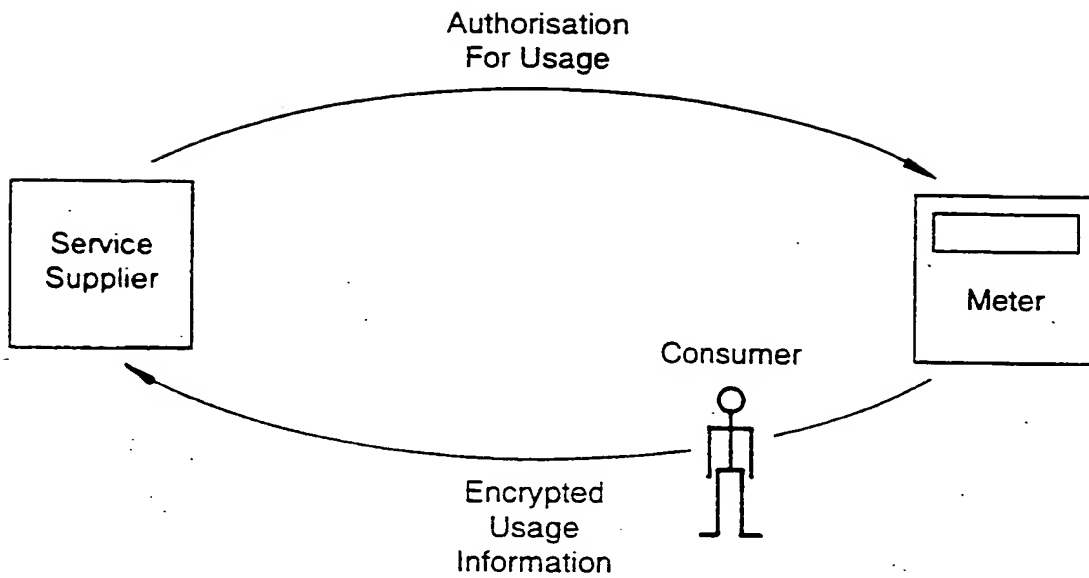
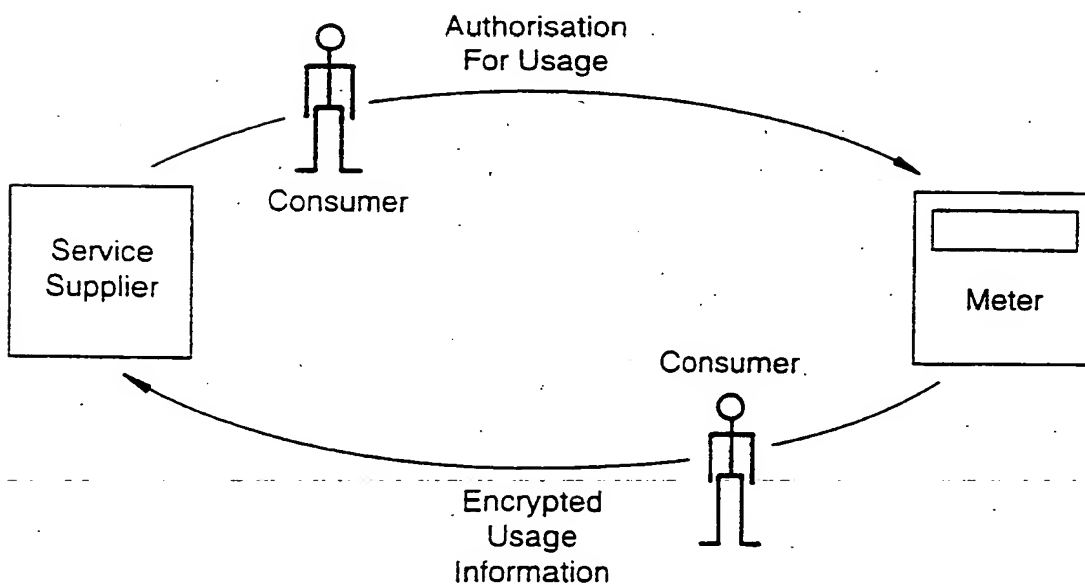
10 In Figure 6c which represents an alternative preferred token to convey a meter reading to the service supplier, the sequence of 28 bits are divided into just two fields bin1 58 and bin2 54, containing 16 and 12 bits respectively. These fields may be used to represent absolute values of consumption during repeated intervals such as day and night, or peak and off peak periods. Alternatively the fields may represent actual monetary amounts which have been determined by the microprocessor 10 from stored tariff information.

CLAIMS:

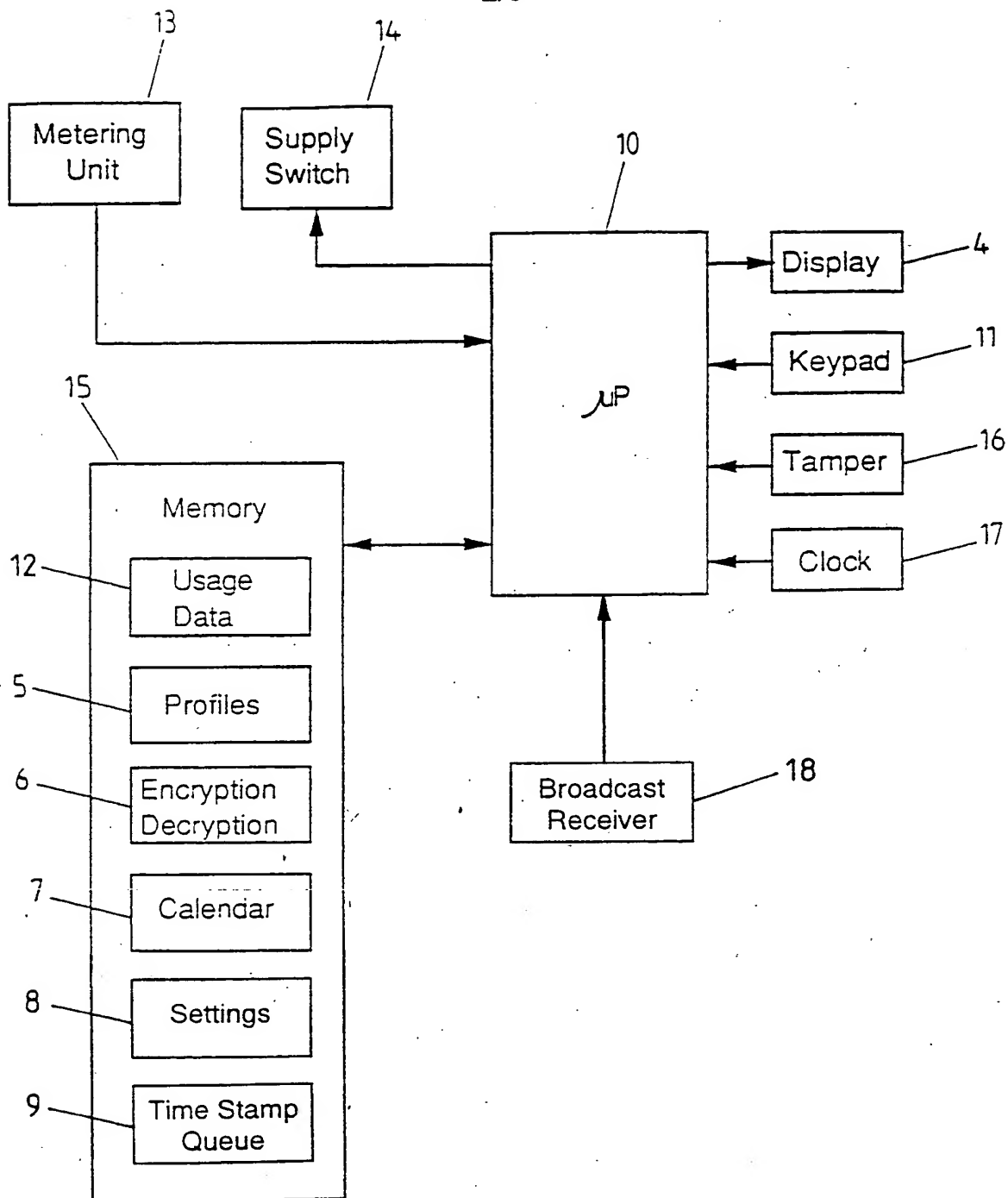
1. Meter apparatus for location at consumer premises, including: memory means which receives and stores information relating to usage of a service by the consumer, processing
5 means which retrieves and encrypts the usage information, and output means by which the encrypted information is presented to the consumer.
2. Apparatus according to claim 1 further including input means by which the consumer or the service supplier prompts the processing means to encrypt and present the usage
10 information.
3. Apparatus according to claim 1 wherein the output means presents the encrypted information visually in a predetermined format.
- 15 4. Apparatus according to claim 1 further including metering means which monitors and/or controls use of the service by the consumer and provides usage information for the memory means.
- 20 5. Apparatus according to claim 1 further including signal reception means by which a service supplier organisation is able to remotely control operation of the apparatus.
6. A method of processing and providing information at consumer meter apparatus in a service metering system, including: receiving a prompt from the consumer or the service
25 supplier that information is required, retrieving usage information from storage in the meter apparatus, encrypting the retrieved information, and providing the encrypted information for the consumer.
7. A method according to claim 6 wherein the consumer manually prompts the system to provide the encrypted information.
30
8. A method according to claim 6 wherein the encrypted information is provided for the consumer in a visible form.
9. A method according to claim 6 further including combining other meter related
35 information with the usage information, and encrypting the combined information,

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10. A method of conveying usage information from a consumer site to a service supplier site, including: recording the usage information in meter apparatus at the consumer site, encrypting the usage information when prompted by the consumer or the service supplier, providing the encrypted information to the consumer in a readable form, and receiving the encrypted information from the consumer at the service supplier site.
- 5
11. A method according to claim 10 wherein the consumer prompts encryption and provision of the usage information by activation of a manual control at the consumer site.
- 10
12. A method according to claim 10 wherein the encrypted information is provided on a display in a fixed length format.
13. A method according to claim 10 wherein the encrypted information is received by the service supplier from the consumer over a telecommunications system.
- 15
14. A method according to claim 10 further comprising decrypting and analysing the received information, and offering the consumer a rebate on future usage as result of the analysis.

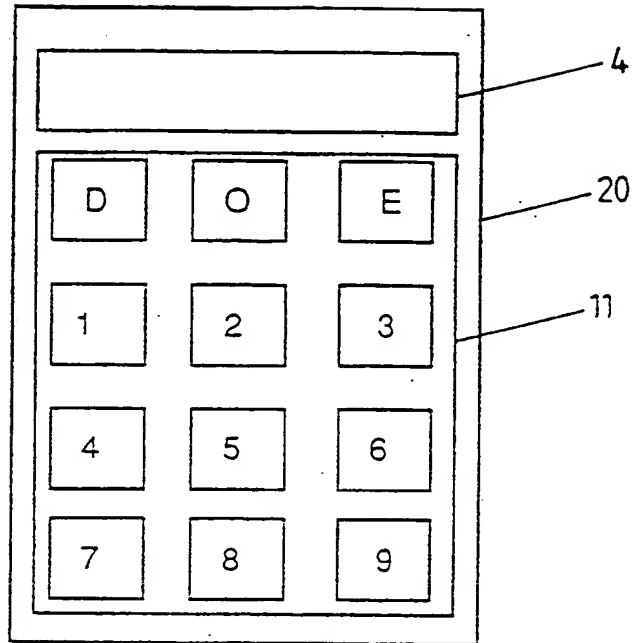
**Figure 1a****Figure 1b**
SUBSTITUTE SHEET (Rule 26)

2/6

**Figure 2**

SUBSTITUTE SHEET (Rule 26)

3/6

**Figure 3**

SUBSTITUTE SHEET (Rule 26)

4/6

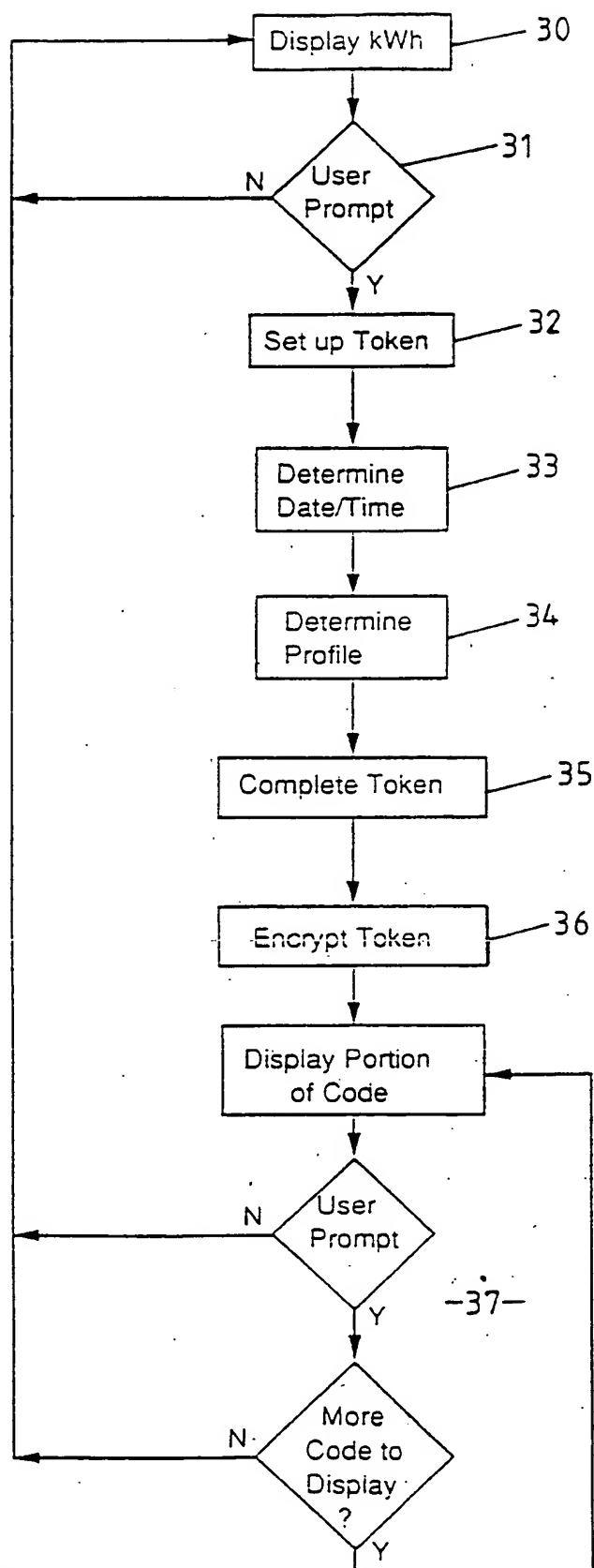


Figure 4

SUBSTITUTE SHEET (Rule 26)

5/6

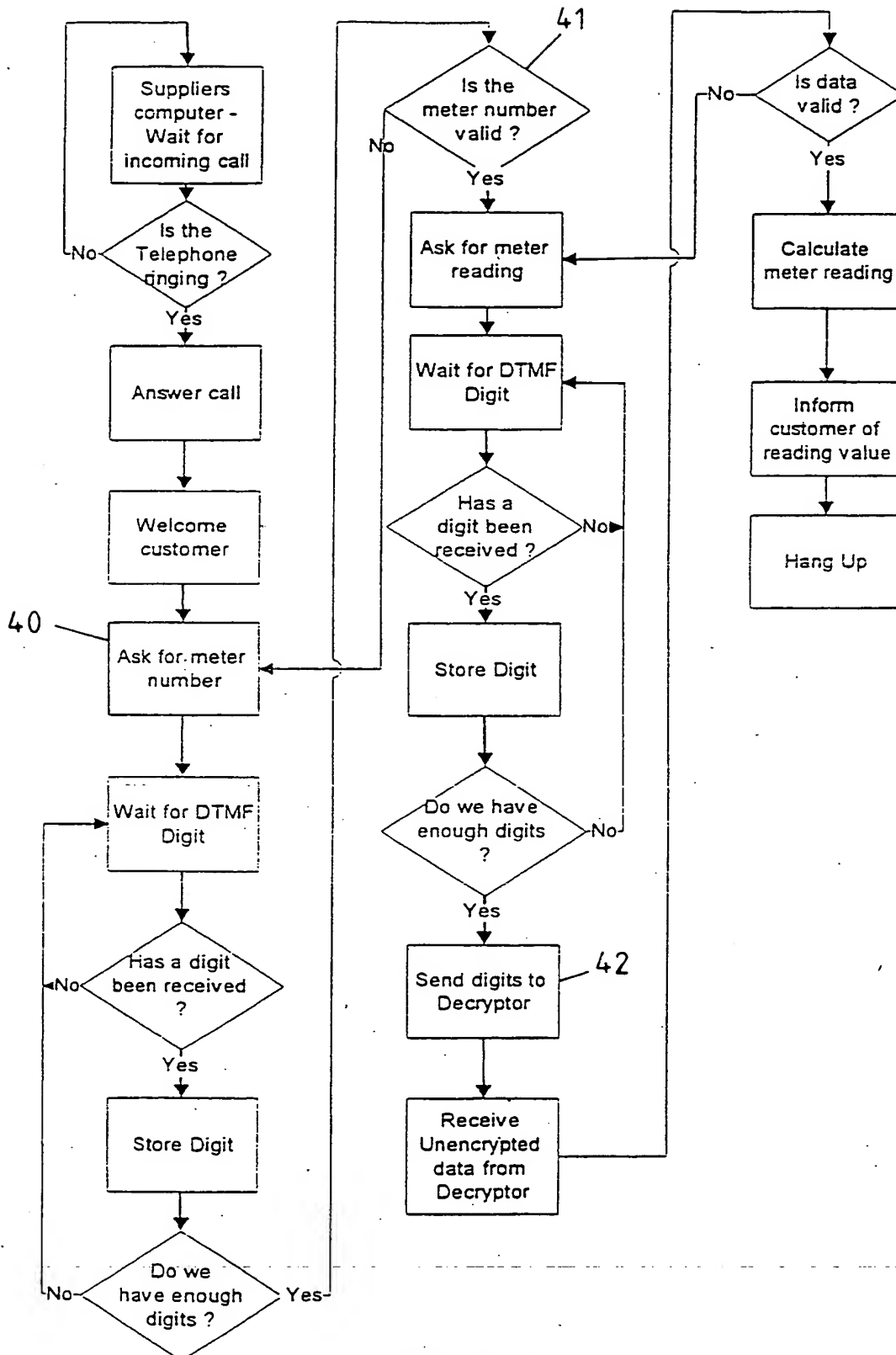


Figure 5

SUBSTITUTE SHEET (Rule 26)

6/6

50 /	51 /	60 /	52 /	54 /	53 /
HDR	CLASS	RND	TIME	AMOUNT	CHKSUM
2	4	4	24	16	16

Figure 6a

50 /	51 /	52 /	55 /	56 /	57 /	53 /
HDR	CLASS	TIME	TOTAL	WD PROFILE	WE PROFILE	CHKSUM
2	4	16	16	6	6	16

Figure 6b

50 /	51 /	52 /	58 /	54 /	53 /
HDR	CLASS	TIME	BIN 1	BIN 2	CHKSUM
2	4	16	16	12	16

Figure 6c

SUBSTITUTE SHEET (Rule 26)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ98/00073

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : H04L 9/00
US CL : 380/9, 49, 55

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 380/9, 49, 55

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

search terms: meter, encrypt, encipher, memory

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,629,874 A (PUGSLEY et al) 16 December 1986, abstract and Figure 1.	1-13
X	US 5,377,268 A (HUNTER) 27 December 1994, abstract and Figure 1.	1-14
X	US 4,827,508 A (SHEAR) 02 May 1989, abstract and Fig. 3	1-13

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	* T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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* O document referring to an oral disclosure, use, exhibition or other means	
* P document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

02 SEPTEMBER 1998

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19 OCT 1998

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/15134

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G07F15/00 G07F7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G07F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 208 955 A (THE GENERAL ELECTRIC COMPANY) 19 April 1989 (1989-04-19) page 3, line 12 -page 5, line 26; figure ---	1-22
A	US 5 146 067 A (SLOAN ET AL.) 8 September 1992 (1992-09-08) cited in the application column 3, line 42 -column 4, line 25 column 10, line 31 - line 56; figures -----	1-22



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 00/15134

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